

Assessment of weekly workload in relation to match workload in U-21 football: Analysis of ten competition microcycles

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Abstract

Football has experienced considerable technological and methodological advancements, which have also influenced youth football. Currently, youth development faces the challenge of preparing players who can meet the rigorous demands of modern football. Objective: To assess and compare the internal and external training throughout the microcycle (MD-4 to MD-1) with the match-day load in under-21 players from a professional team. Method: Sixteen under-21 footballers from a Chilean professional club (age: 24.9 ± 4.2 years; height: 180.9 ± 6.3 cm; body mass: 78.5 ± 8.5 kg) were monitored over 10 official microcycles corresponding to the Fundación-Collahuasi youth football championship, organized by the Chilean Football Federation. Results: Large differences ($p < 0.001$ and $\eta^2 p > 0.2$) were found in all variables between the training days and match day. The highest external load occurred on match day, particularly in TD ($10,087 \pm 708$ m), HSR (709 ± 316 m), and PL (130 ± 21.1 au). The highest weekly training loads were recorded on MD-3 and MD-2, while MD-1 showed significant reductions in all variables. Internal load was also highest on match day (RPE: 7.87 ± 1.54) compared to training sessions. Conclusion: There are significant differences in internal and external load throughout the competitive microcycle in under-21 footballers. MD-3 stands out as the highest-load training day, with values comparable to match day in most variables, positioning it as a key session in the weekly plan. In contrast, MD-1 consistently showed the lowest loads, confirming its role as a tapering day before competition.

Keywords: Soccer, Young athlete, Physical performance, External load, Internal load.

Introduction

Contemporary football has undergone considerable evolution, integrating significant advances in technology, performance analysis, training methodologies, and applied sports sciences (Relvas et al., 2010). In this context, youth football is not lagging behind; far from being limited to basic preparation, it now faces the challenge of developing players capable of adapting to the increasing physical, technical, tactical, and emotional demands of the modern game (Di Salvo et al., 2007). This transformation requires structured planning, a coherent methodology, and continuous monitoring of training loads—key factors in ensuring the holistic and sustainable development of future footballers (Buchheit & Laursen, 2013).

Numerous studies have explored the distribution of training load across the weekly microcycle in professional football teams (Campos-vazquez et al., 2021; Gómez-Díaz et al., 2024; Martín-García et al., 2018a, 2018b; Owen et al., 2020), highlighting a progressive loading pattern towards the middle of the week and a

reduction in the days leading up to the match—particularly on MD-1—in pursuit of physiological supercompensation, a strategy commonly referred to as tapering (Malone et al., 2017a). Variables collected through global positioning systems, such as total distance (TD), high-speed running (HSR), accelerations (AC), and decelerations (DC), alongside internal indicators such as rating of perceived exertion (RPE), enable practitioners to accurately characterise the physical demands of each training session and compare their magnitude with match-day loads (Stevens et al., 2017). For instance, studies involving English Premier League and Spanish First Division teams have reported that TD during matches can exceed 10,000 metres, whereas training sessions typically range from 3,000 to 6,500 metres depending on the day, with MD-3 and MD-4 being the highest-volume sessions (Campos-vazquez et al., 2021; Fernandes et al., 2022; Malone et al., 2017a; Martín-García et al., 2018b). Similarly, exposure to HSR (>19.8 km/h) during matches may surpass 1,000 metres, while in training it rarely exceeds 600 metres, and is mainly concentrated on MD-3 or MD-4 (Campos-vazquez et al., 2021). Regarding intense AC and DC actions (>3 m/s²), values peak during matches (50–70 per player), whereas in training a substantial reduction is observed, particularly on MD-1, where minimal stimuli are applied to facilitate recovery (Stevens et al., 2017). Comparing training loads to match demands enables coaching staff not only to plan and periodise workloads effectively, but also to assess whether training sessions are successfully replicating the physical requirements of competitive play (Gómez-Díaz et al., 2024).

Nonetheless, despite its practical relevance, gaps remain in the literature regarding how external load is distributed across training microcycles in youth football, and how these loads compare to actual match demands. Most of the available studies have been conducted on adult players competing in elite European leagues (Campos-vazquez et al., 2021; Stevens et al., 2017), with limited evidence on load distribution in advanced developmental categories such as U21. This stage, which is particularly critical within the South American context, represents a transitional phase towards professional football, marked by high training and competitive demands, alongside ongoing physical, cognitive, and emotional maturation processes (Kobal et al., 2016). Understanding these dynamics is essential for designing training sessions that align with the actual demands of the game, thereby minimising the risk of both overload and under-stimulation (Gabbett, 2016). Accurate load monitoring supports the physical, technical, and tactical consolidation of players, enhancing their readiness for the professional level (Rebelo et al., 2014). Moreover, planning based on real data may contribute not only to performance improvements but also to sustainable long-term development (Lloyd & Oliver, 2012). Assessing the proximity between training and match loads is therefore fundamental within the developmental framework of youth football (Oliva-Lozano et al., 2021).

Therefore, the aim of this study was to assess and compare the internal and external training loads across the microcycle (from MD-4 to MD-1) relative to match-day load in U21 players from a professional football team in Chile. It was hypothesised that both internal and external loads would be significantly greater during matches compared to training days, following a decreasing load structure towards MD-1 in line with a tapering strategy. Furthermore, differences were expected between training days, reflecting a planning model oriented towards pre-match recovery.

Methods

Design

A quantitative, descriptive, and comparative design with an unbalanced longitudinal approach was employed, based on structured data in long format (Hernández Sampieri, 2018). The analysis focused on identifying differences in internal and external loads according to the day relative to the match (MD-4 to MD), taking into account inter-individual variability through linear mixed models.

Participants

A total of 16 U21 football players from a professional Chilean club (age: 18.9 ± 0.91 years; height: 180.9 ± 4.3 cm; body mass: 76.5 ± 4.5 kg) were monitored across 10 official microcycles during the Fundación Collahuasi youth football championship, organised by the Chilean Football Federation. The inclusion criteria were: (a) having played the full duration of each analysed match within the microcycles, and (b) being free from any injury that could have limited their participation at the time of data collection.

Ethical Considerations

All participants, along with the club's management, provided informed consent. The players held valid federation licences, underwent medical evaluations at the beginning of the season in accordance with the requirements of the Chilean Football Federation, and participated in the absence of injury or discomfort. The monitoring process did not alter regular training practices nor involve any additional risk beyond that inherent to football activity; therefore, ethical committee approval was not required (Winter & Maughan, 2009).

Procedures

The study was conducted during the 2024 Clausura season, covering 10 consecutive competitive microcycles. Each microcycle followed a standard weekly structure from Tuesday to Saturday, consisting of four training sessions and one official match, while Sunday was allocated for rest and Monday for compensatory training for players who did not participate in the match (Stevens et al., 2017). All sessions were held at 10:00 AM on the same training pitch and followed a pre-established methodological framework set by the coaching

staff (see Figure 1). Sessions were classified according to their proximity to match day, using standard nomenclature: MD-4 (four days prior), MD-3, MD-2, MD-1 (day before), and MD (Match Day) (Stevens et al., 2017). Each session was designed with specific physical and tactical objectives: MD-4 and MD-3 involved higher volume and intensity; MD-2 consisted of a moderate-load tactical rehearsal; and MD-1 included a short, low-load activation session. Match-day load (MD) was considered the weekly maximum reference for both absolute and relative comparisons. On match days, all players performed a standardised warm-up led by the fitness coach, lasting between 20 and 25 minutes. This included joint mobility drills, passing and control exercises, small-sided games, and offensive and defensive organisation tasks. For analytical purposes, the pre-match warm-up was excluded, and only data from the official match time were considered.

Figure 1. Schematic representation of the microcycle structure according to the training tasks and contents implemented.

MD-4	MD-3	MD-2	MD-1	MD	MD+1
Strength	Duration	Velocity	Activation	Match day	Off
Physical training	Physical training	Physical training	Physical training	Soccer warm up	
Core training (10')	Core training (10')	Core training (10')	Coordination drills (15')	(25') General exercises for joint mobility, control, and passing, games in reduced spaces, defensive block work, and offensive block work	
dynamic and isometric contraction exercises	dynamic and isometric contraction exercises	dynamic and isometric contraction exercises	Individual and collective technique with the ball		
Lower Body strength	UB strength	Speed Block			
3-5 sets / 3-6 r	3-5 sets / 3-6 r	(20'):			
30-60% 1RM	30-60 %1RM	Unresisted sprints			
Squat	Bench Press	Linear sprints			
Deadlift	Pull-Ups	from 10-m to 30-m			
Hip thrust	TRX Pull-Ups	Change of direction and agility training from 10-m to 20-m			
	Shoulder Push-Ups				
	Intermittent training				
	1-2 sets x 6-8 rep on 100 meters 90-120% YYIRT-L1				
TEC/TAC (~60')	TEC/TAC (~90')	TEC/TAC (~80')	TEC/TAC (~50')	Competition	
Dueling actions, few players in small spaces <60 m ² pp	Greater number of players in larger playing spaces >60 m ² pp	Fewer players in larger playing spaces >90 m ² pp Fixed tactic defensive	Few players in small spaces <60 m ² pp Fixed tactic offensive		
Cool-down (10')	Cool-down (10')	Cool-down (10')	Cool-down (10')	Cool-down (10')	

Abbreviations: TEC/TAC: technical and tactical training, YYIRT-L1: yo-yo intermittent fitness recovery test level one speed, 1RM: 1-repetition maximum, pp: per player.

Variables and Instruments

Internal Load: Rating of Perceived Exertion (RPE)

To subjectively quantify the intensity of each match, the players' rating of perceived exertion (RPE) was assessed 30 minutes after each match, using the protocol described by Borg et al. (Borg et al., 1987), on a scale from 0 to 10. Players responded individually, without teammates present, to minimise response bias [21]. This method has been validated as an effective tool for monitoring training and match intensity in football players (Alexiou & Coutts, 2008; Flatt & Esco, 2015).

External Load: GPS Monitoring

Players' external load during each training session and match was monitored using GPS devices (WIMU Pro®, RealTrack Systems, Almería, Spain), with a sampling frequency of 10 Hz and an integrated 3D accelerometer operating at 100 Hz. Each device was secured in a neoprene vest worn tightly between the scapulae to ensure accurate data collection. The variables considered for analysis included total distance (TD), high-speed running (HSR; >19.8 km/h), peak speed (PS), number of accelerations (AC) and decelerations (DC)

greater than 3 m/s², and player load (PL). These metrics are commonly used to monitor training load and to assess and report player performance during official football matches in men's football (FIFA, 2018; Stevens et al., 2017).

Statistical Analysis

As player participation varied across microcycles and not all athletes took part in every training or match day, a linear mixed model (LMM) was used to compare internal and external loads between MD-4, MD-3, MD-2, MD-1, and MD. This approach allowed for the management of the unbalanced design (missing data) and accounted for the dependency of repeated measures from the same player. Each variable (RPE, TD, HSR, PS, AC, DC, and PL) was analysed separately, with the day of the microcycle included as a fixed effect and the player as a random effect. Bonferroni correction was applied for post hoc comparisons, and effect sizes were reported using partial eta squared (η^2p), interpreted according to the following thresholds: small (<0.01), moderate (0.01–0.06), and large (≥ 0.14) (Lakens, 2013). All analyses were conducted using IBM SPSS Statistics version 27.0, with a significance level set at $\alpha = 0.05$.

Results

The analysis revealed large differences ($p < 0.001$; $\eta^2p > 0.2$) in all variables between microcycle days and match day. The highest external loads were observed on match day, particularly in total distance (TD: 10,087 $\pm$ 708 m), high-speed running (HSR: 709 $\pm$ 316 m), and player load (PL: 130 $\pm$ 21.1 au). The highest training loads during the week were recorded on MD-3 and MD-2, while MD-1 showed significant reductions across all variables. Internal load was also greater during the match (RPE: 7.87 $\pm$ 1.54) compared to training sessions.

Table 1. Mean $\pm$ standard deviation of internal and external load variables across the microcycle days (MD-4 to MD) in U21 players.

Variables	MD-4	MD-3	MD-2	MD-1	MD	<i>p</i> value	η^2p	Mag.
RPE (0–10)	4.75 $\pm$ 1.84 ^d	6.71 $\pm$ 1.87 ^c	4.93 $\pm$ 1.38 ^d	3.56 $\pm$ 1.93 ^d	7.87 $\pm$ 1.54	<0.001	0.618	Large
DUR (min)	61.27 $\pm$ 19.49	89.88 $\pm$ 12.84	79.77 $\pm$ 10.16	48.61 $\pm$ 18.73	95.38 $\pm$ 5.41	<0.001	0.642	Large
TD (m)	4851 $\pm$ 1187 ^d	5818 $\pm$ 831 ^c	5748 $\pm$ 1022 ^d	2964 $\pm$ 951 ^d	10087 $\pm$ 708	<0.001	0.894	Large
HSR (m)	338 $\pm$ 180 ^d	412 $\pm$ 97.1 ^c	323 $\pm$ 101 ^d	129.04 $\pm$ 122 ^d	709 $\pm$ 316.12	<0.001	0.495	Large
PS (km/h)	28.6 $\pm$ 2.97 ^d	26.9 $\pm$ 2.56 ^c	29.1 $\pm$ 2.94 ^d	26.1 $\pm$ 3.97 ^d	29.9 $\pm$ 2.26	0.003	0.203	Large
PL (au)	62.4 $\pm$ 16.7 ^d	79.7 $\pm$ 17.2 ^c	73.2 $\pm$ 15.2 ^d	43.5 $\pm$ 11.0 ^d	130 $\pm$ 21.1	<0.001	0.796	Large
#AC (n)	52.6 $\pm$ 17.6 ^d	57.0 $\pm$ 18.3 ^c	58.5 $\pm$ 18.9 ^d	28.4 $\pm$ 12.6 ^d	61.8 $\pm$ 17.4	<0.001	0.465	Large
#DC (n)	42.44 $\pm$ 16.04 ^d	48.27 $\pm$ 15.89 ^c	52.55 $\pm$ 21.20 ^d	23.83 $\pm$ 9.61 ^d	75.55 $\pm$ 25.60	<0.001	0.618	Large

Values are presented as mean $\pm$ standard deviation.

Post hoc analysis: Bonferroni correction. Superscript letters indicate significant differences: ^a = different from MD-3; ^b = different from MD-2; ^c = different from MD-1; ^d = different from MD.

Abbreviations: RPE = Rating of Perceived Exertion; TD = Total Distance; DUR = Duration; HSR = High-Speed Running; PS = Peak Speed; AC = Number of Accelerations; DC = Number of Decelerations; PL = PlayerLoad.

Table 2 presents the normalised values of internal and external load recorded on each training day (MD-4 to MD-1), expressed as a proportion relative to match day (MD = 1). MD-3 showed the highest values (ranging from 58% to 92%), whereas MD-1 recorded the lowest loads (18% to 62%), reflecting an undulating distribution of weekly training load.

Table 2. Daily proportion of internal and external load during a typical microcycle relative to match day (MD = 1) in U21 football players.

Variables	MD-4	MD-3	MD-2	MD-1	Match day
RPE (0–10)	60%	85%	63%	45%	100%
DUR (min)	64%	86%	76%	46%	100%
TD (m)	48%	58%	57%	29%	100%
HSR (m)	48%	58%	46%	18%	100%
PS (km/h)	96%	90%	97%	87%	100%
PL (au)	85%	92%	95%	46%	100%
#AC (n)	56%	64%	70%	32%	100%
#DC (n)	48%	61%	56%	33%	100%

Abbreviations: RPE = Rating of Perceived Exertion; TD = Total Distance; DUR = Duration; HSR = High-Speed Running; PS = Peak Speed; AC = Number of Accelerations; DC = Number of Decelerations; PL = PlayerLoad.

Figure 2 illustrates the proportional distribution of weekly training load from MD-4 to MD-1 relative to match day (MD = 1). The highest values were observed on MD-3 (60–90% of match load, depending on the variable), with a progressive decline towards MD-1 (18–62%). Both internal and external loads followed a pattern consistent with an undulating training structure, with MD-3 emerging as the most demanding day of the microcycle.

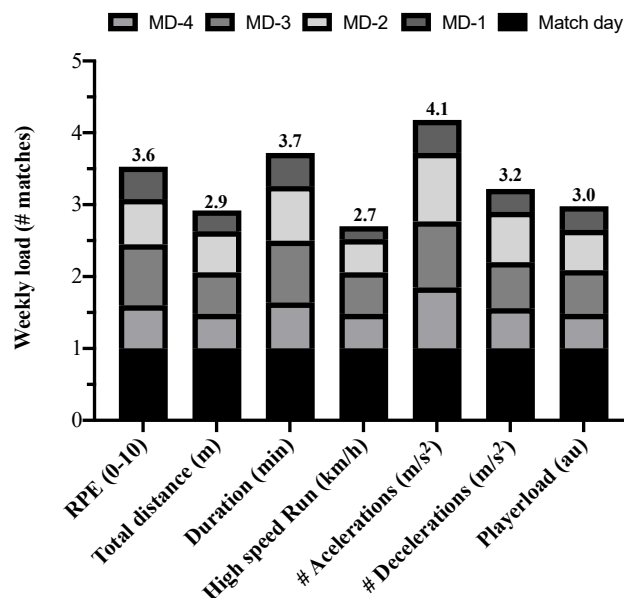


Figure 2. Typical weekly profile of training load relative to match day (MD = 1) in U21 football players.

Discussion

The aim of this study was to quantify and compare the external training load across microcycle days (MD-4 to MD-1) relative to match day (MD) in U21 players from a professional football team. The main findings indicate that the highest load occurred on match day for most variables, while significantly lower loads were recorded on the preceding days, particularly on MD-1. In addition, statistically significant differences were found between microcycle days, with large effect sizes in most cases, highlighting load distribution patterns that reflect a logically structured microcycle in terms of training load and recovery (Anderson et al., 2016).

With regard to RPE, an increase was observed from MD-4, peaking on MD-3 (6.71 ± 1.87), followed by a reduction on MD-2 and MD-1, and a subsequent increase on match day, which recorded the highest value of the microcycle (7.87 ± 1.54 ; $p < 0.001$; $\eta^2 = 0.618$). This undulating pattern indicates that the greatest perceived exertion occurs during the match, while MD-3 represents the most demanding training day in terms of internal load. These findings are consistent with previous studies reporting that matches represent the highest internal load perceived by players (Impellizzeri et al., 2005), and that mid-week sessions tend to concentrate greater tactical and physical demands (Gabbett, 2016).

Regarding total distance (TD), significant differences were observed ($p < 0.001$; $\eta^2 = 0.894$), with the highest value recorded on match day ($10,087.39 \pm 708.24$ m). This value was approximately 3.4 times greater than the distance covered on MD-1 ($2,964.45 \pm 951.96$ m), representing just 29% of the match load and highlighting a progressive and systematic reduction in load towards the end of the microcycle. These findings are consistent with those of Malone et al. (2017), who reported a tapering pattern in the days prior to competition as a strategy to optimise performance. Complementarily, the total duration of the sessions also showed a distribution that reinforces this trend: match day reached the highest accumulated duration, while MD-3 represented 86% and MD-1 the shortest (46%) relative to match day, confirming the progressive reduction in training load leading up to the main competitive event.

For the HSR variable, a significant increase was observed towards match day (709.6 ± 316.12 m; $p < 0.001$; $\eta^2 = 0.495$), which was substantially higher than the value recorded on MD-1 (129.04 ± 122.12 m), representing only 18% of the match-day exposure. This finding highlights the challenge of replicating match-level high-speed demands during training, as noted by Akenhead & Nassis (2016), and suggests the need for specific strategies to stimulate this capacity throughout the week. MD-3 recorded the highest HSR value within the microcycle (412.21 ± 97.12 m), equivalent to 58% of the match-day load, which may be interpreted as a key day for exposure to high-intensity efforts (Campos-vazquez et al., 2021; Stevens et al., 2017).

Peak speed (PS) also showed significant differences across days ($p = 0.003$; $\eta^2 = 0.203$), with the highest values recorded on match day (29.91 ± 2.26 km/h). Although training sessions include periods of high intensity, the values reached on MD-1 (26.13 ± 3.97 km/h) and MD-3 (26.96 ± 2.56 km/h) represented only 87% and 90% of match-day values, respectively. Studies such as those by Dalen et al. (2016), support the observation that maximum speed values are rarely matched during training, due to the unpredictable and competitive nature of match play. Consequently, the systematic inclusion of sprint-specific stimuli—designed to elicit maximum speed at least once per week through analytical drills—has been proposed. This strategy not only enhances specific physical preparedness by replicating match-related sprint demands, but has also been shown to reduce the risk of hamstring injuries, particularly in players exposed to high-speed demands (Mendiguchia et al., 2016).

Both accelerations (AC) and decelerations (DC) followed similar patterns, with peak values recorded on match day (61.83 ± 17.43 and 75.55 ± 25.6 , respectively) and the lowest values on MD-1 (28.44 ± 12.68 and 23.83 ± 9.61). The differences were statistically significant ($p < 0.001$), with moderate to large effect sizes ($\eta^2 = 0.465$ and 0.618). In relative terms, accelerations on MD-1 accounted for only 46% of the match-day value, while decelerations represented just 32%. These actions, which are critical to match performance, impose a high mechanical and metabolic load, justifying their planned reduction on low-load days (Barrett et al., 2016). The literature supports this approach, emphasising that modulation of these variables is essential for injury prevention and performance optimisation (McLaren et al., 2018). A similar pattern was observed in player load (PL), which showed a marked difference between match day (130.42 ± 21.1 au) and the rest of the week, particularly MD-1 (43.53 ± 11.05 au; $p < 0.001$; $\eta^2 = 0.796$). This value represents only 33% of the physical exertion experienced on match day. As a composite index, PL reinforces the trends observed in the other variables, serving as a general reflection of the accumulated physical stress on each day (Hulin et al., 2018). Its high value on match day highlights its utility as a benchmark for designing and adjusting weekly training load (Barrett et al., 2016).

Nevertheless, this study is not without limitations that should be acknowledged. The sample size was limited to a single age category (U21) and one team, which restricts the generalisability of the findings. Moreover, contextual match variables (such as opponent quality, home vs away status, and match outcome) were not considered, nor were individual physiological responses. A further relevant limitation is the lack of individualisation in both internal and external load monitoring, as well as the absence of a positional analysis. This omission limits the ability to identify variations in physical demands based on each player's tactical role—an essential aspect for tailoring training prescriptions to individual and positional needs, particularly with regard to distance covered at different intensities (Baptista et al., 2019).

From an applied perspective, the findings of this study provide specific reference values for each day of the microcycle, enabling weekly planning to be aligned with the actual demands of competition. Identifying the highest-load day (MD-3, reaching approximately 85% of match-day RPE and 58% of HSR) and the lowest-load day (MD-1, with less than 30% of TD and PL) is key to appropriately distributing training loads, implementing effective recovery strategies, and reducing the risk of overload. In this context, it is recommended to include high-intensity stimuli—particularly maximal sprinting—at least once per week. This strategy not only simulates the demands of match play but has also been shown to be effective in preventing muscular injuries, especially those involving the hamstrings (Mendiguchia et al., 2016).

Conclusion

Based on the results obtained, it can be concluded that significant differences exist in both internal and external load across the competitive microcycle in U21 football players. MD-3 emerged as the highest-load day, displaying values comparable to match day for most of the variables analysed, thereby positioning it as a key session within the weekly training structure. In contrast, MD-1 consistently presented the lowest loads, reaffirming its role as a tapering day prior to competition.

Conflicts of interest

The authors declare that they have no conflicts of interest

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